

2009 West Virginia State University Research Plan of Work

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I. Plan Overview

1. Brief Summary about Plan Of Work

West Virginia State University (WVSU) became fully reinstated as an 1890 Land-Grant Institution in November of 2001. However, the University began the reactivation of its research programs in FY 2000. The Department of Land-Grant Programs was officially established on March 17, 2000 and charged with the mission of administer land-grant related research and extension programs. In order to better accommodate the growth of this unit and to better serve the University's constituents, the Department was elevated to a Division of Agricultural, Consumer, Environmental, and Outreach Programs (or Division of ACEOP) in 2003; and on March 15, 2006, the Division became "The Gus R. Douglass Land-Grant Institute". The mission of the Institute remains that of delivering the institution's land-grant mission related to the dissemination of research, teaching, and extension services to the state's citizens.

Federal support has been one of the key success factors of the Institute. Formula funding for FY 2006 was maintained at slightly over \$1 M for research. More recently, state appropriated dollars, to meet the matching of its formula funding, have been infused in furthering the advancement of the University's Land-Grant Research Programs. In fact, the State Legislature appropriated in FY 2006 state dollars to meet the 90% match, and secured a line item within the institution's budget to meet the match in the years thereafter. As state appropriations and other federal and non-federal resources are attained, the University has now begun extending its research portfolio and building research capacity.

This plan of work for West Virginia State University focuses on plant genomics, environmental microbiology and remediation, aquaculture, and biotechnology. The University has a diverse group of research scientists with expertise in the fields of analytical chemistry, genetics, nutrition, and microbiology. The research addresses several challenges to the agriculture and energy industries. The strengths of the program for the past five years have been agricultural waste management and microbiology. This five year plan will include some aspects of the previous plan, however the primary focus is now on plant genomics. Research scientists have obtained several external equipment grants and over the past two years have gathered the necessary infrastructure, including three DNA sequencers, to move forward with planned genomics research. Facilities include several on campus analytical laboratories, an aquaculture facility, off-campus laboratories, two greenhouses, and a pilot plant anaerobic digester. Currently two scientists have full-time research appointments and six scientists are supported part-time. West Virginia State University recently obtained accreditation for an MS program in biotechnology. This has allowed the research program to support graduate assistants and has benefited the research scientists by providing technical and research capacity that did not exist at the university prior to the inception of graduate programs.

West Virginia University and West Virginia State University entered into a voluntary agreement in 1997 to create the West Virginia Association of Land-Grant Institutions; a collaboration of the state's two land-grant institutions committed to providing education that would help the citizens of West Virginia improve their lives and communities. More recently (in 2005), triggered by an USDA-CSREES mandate, the two Universities developed a Comprehensive Plan for the State which superseded the former agreement. This plan assures appropriate coordination between the two institutions to avoid duplication of efforts, as it relates to their research and extension programming, and thus an efficient investment of human and financial resources within the State. Therefore, research at West Virginia State University is coordinated with the West Virginia Experiment Station. Supporting research at West Virginia University focuses on economic activities for which West Virginia conditions provide competitive advantage for producers and on problems having particular impact on families and communities within the state.

Estimated Number of Professional FTEs/SYs total in the State.

Year	Extension		Research	
	1862	1890	1862	1890
2009	0.0	0.0	0.0	11.5
2010	0.0	0.0	0.0	11.5
2011	0.0	0.0	0.0	11.5
2012	0.0	0.0	0.0	12.0
2013	0.0	0.0	0.0	12.0

II. Merit Review Process**1. The Merit Review Process that will be Employed during the 5-Year POW Cycle**

- Combined External and Internal University External Non-University Panel

2. Brief Explanation

Each year, during the months of April and May, all research programs are subjected to a review process. The process includes an internal and external evaluation. An oral presentation at the WVSC Annual Research Symposium is a key component of the overall annual evaluation and it is required for land-grant sponsored researchers. Stakeholders identified by the procedures outlined below are invited to the Symposium. The internal evaluation consists of an Office and/or Departmental appraisal by the executive staff. Additionally, all participants in land-grant sponsored research critically assess the research of fellow colleagues for developmental purposes.

A research advisory panel conducts the external program evaluations. The research advisory panel consists of local scientists with a wide variety of backgrounds, business leaders and other community members considered as suitable stakeholders for research programs. The evaluations from these panels are utilized to help rank and allocate funds to specific land-grant programs. Evaluation assessing research productivity versus resources spent will be included in the ranking of continuing projects to facilitate funding decisions during the next budget year or cycle.

III. Evaluation of Multis & Joint Activities**1. How will the planned programs address the critical issues of strategic importance, including those identified by the stakeholders?**

Critical and strategic issues in West Virginia, driving the design of planned research programs, are identified internally and externally by advisory group panels in a consistent basis. The proposed planned programs in the new POW have been reviewed by internal and external panels. External stakeholders comprising the advisory panel consist of a group of individuals and professionals from related fields being addressed by the research programs. Each year, research programs are fine-tuned according to the to stakeholders inputs so they can be responsive to the relevant issues in the state. In addition, research scientists also cultivate links to individuals, institutions, and organizations and use feedback to tailor their projects to specific needs expressed by stakeholders. WVSU's planned programs are closely coordinated with WVU's programs so that no duplication of efforts occur and also to take advantage of collaborative opportunities. Issues related to the protection of the environment and its natural resources are considered critical in West Virginia as the chemical and coal industries have had impacts on water quality, soil conservation, wildlife, and natural resources. Thus, planned programs at WVSU have an environmental component that should provide solutions to these problems, and facilitate better management of the environment and its resources. Specific multi state and joint activities for each program include the following:

- Plant Genomics: USDA ARS South Carolina, Plant Breeding Coordinating Committee, Alcorn State University, Alabama A&M, Texas A&M, Cornell, Penn State, University of Florida and Ohio State.
- Natural Resources Management: West Virginia University

- Alternative Agriculture: University of Minnesota, West Virginia University, Mississippi State, Arkansas, Kentucky State, and Cornell
- Environmental Microbiology: West Virginia State University
- Aquaculture: 1890 Universities Aquaculture Consortium, Mississippi State University, Cold and Cool Water Fish Laboratory
- Agricultural Biotechnology: Texas A&M, Alcorn State University
- Opportunities also exist for joint and multi state research and extension for the applied research programs aquaculture and alternative agriculture programs: Kentucky State University

2. How will the planned programs address the needs of under-served and under-represented populations of the State(s)?

West Virginia has historically been an economically depressed state. As a result, many of the state's citizens fall with the category of under -served and under-represented. Landowners are especially a focus of research programs. Environmental issues relating to mineral extraction and water quality are addressed by the research programs. Small farms will benefit from plant genomics research to improve insect and disease resistance of vegetable crops, potentially reducing input cost and improving yield. Waste management of animal manures is an issue facing several small and medium size farms in the state. The environmental microbiology program characterizes the potential impact of these wastes on well and stream water quality. This is especially important to rural residents that do not have access to a municipal water sources.

3. How will the planned programs describe the expected outcomes and impacts?

The expected impact of this research on the state will be commensurate to the impact of each individual project. The collection of projects results in medium or long term programs, with both short-term and long-term outcomes. Each program is designed so measurable impacts to the identified stakeholders are quantified. It is important to point out that while some research projects within each program are very fundamental and may only result in advancing research tools or techniques, others have the potential to have an impact on government regulatory agencies, private businesses, and individual citizens within the state and/or region. The expected impacts for each program are:

- Plant Genomics: 1. Genomic resources to facilitate plant breeding 2. Production of superior cultivars of vegetable crops, cotton, and spices.
- Natural Resources Management: 1. Improved water quality as a result of novel metal remediation technology 2. Improved air quality as a result of novel carbon sequestration technology
- Alternative Agriculture: 1. More profitable small farm operations through novel production methods
- Aquaculture: More profitable operations as a result of novel production practices that improve competitiveness
- Environmental Microbiology: 1. More efficient digester operation as a result of microbial monitoring systems 2.

Reduction in antibiotic resistant bacteria

Agricultural Biotechnology: Increased crop yields through introduction of superior quality Rubisco or other agronomic enzymes that are being investigated.

4. How will the planned programs result in improved program effectiveness and/or efficiency?

The research programs at West Virginia State University continue to evolve based on the outputs and outcomes measured for past programs. The research administrative unit, continuously reviews all projects within the program areas. The projects and programs that progress and produce yearly outputs and demonstrate the potential for longer term outcomes have been selected for further funding in this current plan of work. Specific benefits to each program through joint and multi state cooperation include:

- Plant Genomics: Increased intellectual capacity through University and Federal Links, better opportunity to obtain exterior grant funding, access to more resources for research activities, and increased opportunity to develop novel research proposals
- Natural Resources Management: Access to resources not available at WVSU and increased intellectual capacity.
- Alternative Agriculture: Increased intellectual capacity, access to novel plants and genetic materials, increased opportunities for external grant funding, and access to facilitates and resources
- Aquaculture: Increased intellectual capacity and increased opportunity for external grants
- Environmental Microbiology: Increased intellectual capacity and access to equipment and facilities not available at WVSU

Agricultural Biotechnology: Increased intellectual capacity and access to equipment and facilities not available at WVSU

IV. Stakeholder Input

1. Actions taken to seek stakeholder input that encourages their participation

- Targeted invitation to traditional stakeholder groups
- Targeted invitation to traditional stakeholder individuals
- Targeted invitation to non-traditional stakeholder groups
- Targeted invitation to non-traditional stakeholder individuals

Brief explanation.

Potential stakeholders (individuals) are invited to participate on a review panel to evaluate the University's land-grant research programs. Research administrators and research scientists seek individuals and groups within a specific area of expertise or understanding to provide input and shape the direction of the research programs in order to better address the needs of those individuals or groups. Several collaborations have been formed as a result of these activities. Traditional stakeholder groups include industry, departments of agriculture, and individual farmers. Non-traditional groups include non-profit environmental organizations, alternative energy groups and cooperatives, and under-served landowners who have been impacted by mineral extraction.

2(A). A brief statement of the process that will be used by the recipient institution to identify individuals and groups stakeholders and to collect input from them

1. Method to identify individuals and groups

- Other (Researcher Interactions)
- Use Advisory Committees

Brief explanation.

The research advisory committee consists of several individuals representing the different areas addressed by the programs. Target areas are defined based on the research portfolio at the Institution. Within each target area (e.g. farm owners, government agencies, industry, etc.) individuals are identified and invited to participate. These individuals advise the scientists on possible stakeholders and issues important to those stakeholders. The individual research scientists attend professional seminars, special interest meetings and other relevant conferences and have identified stakeholders through interactions with groups or individuals interested in the research.

2(B). A brief statement of the process that will be used by the recipient institution to identify individuals and groups who are stakeholders and to collect input from them

1. Methods for collecting Stakeholder Input

- Meeting specifically with non-traditional groups
- Meeting with traditional Stakeholder groups
- Meeting with traditional Stakeholder individuals

Brief explanation

Inputs are collected during the research advisory review through a specific survey and at the meetings. Minutes and surveys are collected and analyzed to guide the programming process of each semester-cycle.

3. A statement of how the input will be considered

- To Set Priorities
- Redirect Research Programs
- In the Staff Hiring Process
- To Identify Emerging Issues

Brief explanation.

Stakeholder input is necessary to maintain the relevance of the research program. Emerging issues in a specific field may redirect the program or eliminate the need for a specific project within the program. Staffing for particular programs is based in part on the need and importance of that project or program to stakeholders.

V. Planned Program Table of Content

S. NO.	PROGRAM NAME
1	Natural Resource Management
2	Aquaculture
3	Environmental Microbiology
4	Plant Genomics
5	Agricultural Biotechnology
6	Alternative Agriculture

V(A). Planned Program (Summary)**Program #1****1. Name of the Planned Program**

Natural Resource Management

2. Brief summary about Planned Program

This planned program has been updated and contains only one major research undertake. The two previous research projects: (1) develop metal-ion binding technology for use in waters contaminated with heavy metals; and (2) assess photo-initiated, supra-molecular, heterogeneous catalyst technology for its capacity to sequester carbon, while producing methane and methanol, were eliminated for lack of significant contributions by the participant scientist(s). The new program relates to the study of microbial-soil-plant interactions applicable to restoration of mined-land soils. An important component of this program is the incorporation of treated solid waste (anaerobically fermented chicken litter) to improve the organic properties of the soil and thus, increase the microbial-soil-plant interaction. Preliminary studies have shown promising results in relation to land and vegetative restoration of mined/reclaimed soils. Related research at West Virginia University will involve either soil or water quality and will examine the impact of human activity on both.

3. Program existence : Intermediate (One to five years)

4. Program duration : Medium Term (One to five years)

5. Expending formula funds or state-matching funds : Yes

6. Expending other than formula funds or state-matching funds : Yes

V(B). Program Knowledge Area(s)**1. Program Knowledge Areas and Percentage**

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
101	Appraisal of Soil Resources				40%
102	Soil, Plant, Water, Nutrient Relationships				30%
133	Pollution Prevention and Mitigation				10%
403	Waste Disposal, Recycling, and Reuse				20%
	Total				100%

V(C). Planned Program (Situation and Scope)**1. Situation and priorities**

Natural resources research at West Virginia State University addresses the remediation of current threats to the states air, soil, and water. The exploitation of minerals, in particular coal, is the primary activity in the satate. Unfortunately this activity results in the disturbance of mined areas throughout the state. Land reclamation, more importantly its restoration, is very important and critical restorative process. The understanding of microbial-soil-plant interactions is important to accelarate the restoration of mined-land soils. An important component of this program is also the incorporation of treated solid waste (anaerobically fermented chicken litter) to improve the organic properties of the soil and thus, increase the microbial-soil-plant interaction. Preliminary

studies have shown promising results in relation to land and vegetative restoration of mined/reclaimed soils. Related research at West Virginia University will involve either soil or water quality and will examine the impact of human activity on both.

2. Scope of the Program

- In-State Research

V(D). Planned Program (Assumptions and Goals)

1. Assumptions made for the Program

This research program is supported by both CSREES and external funding. The scientist conducting research have specific knowledge of biology-plant and microbial techniques and operation of specialized experimental and analytical equipment necessary to conduct this research. Currently, WVSU provides laboratories and equipment to support this research program. Both extraction and end use of coal are important to the economy of West Virginia. With worldwide energy demand increasing, the price and demand for coal has sharply increased. Associated with more extraction of coal from surface and deep mines is the depletion and disturbance of soil. This research program addresses these issues. Local, state, and federal groups and agencies may be able to use the findings of this research to maintain current production levels while lessening the impact on the soil quality of West Virginia.

2. Ultimate goal(s) of this Program

The ultimate goals of the program include: Repair soil quality; Restore vegetative growth; Utilize treated solid waste to alleviate pollution and contamination.

V(E). Planned Program (Inputs)

1. Estimated Number of professional FTE/SYs to be budgeted for this Program

Year	Extension		Research	
	1862	1890	1862	1890
2009	0.0	0.0	0.0	0.3
2010	0.0	0.0	0.0	0.3
2011	0.0	0.0	0.0	0.3
2012	0.0	0.0	0.0	0.3
2013	0.0	0.0	0.0	0.3

V(F). Planned Program (Activity)

1. Activity for the Program

- Conduct research experiments - Present and/or publish the results

2. Type(s) of methods to be used to reach direct and indirect contacts

Extension	
Direct Methods	Indirect Methods
<ul style="list-style-type: none"> ● Other 1 (Scientific Conferences) 	<ul style="list-style-type: none"> ● Web sites

3. Description of targeted audience

- Watershed and Environmental groups - Mine operators - Mine and Land owners- Environmental regulators

V(G). Planned Program (Outputs)**1. Standard output measures****Target for the number of persons(contacts) to be reached through direct and indirect contact methods**

	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Year	Target	Target	Target	Target
2009	5	0	0	0
2010	5	0	0	0
2011	5	0	0	0
2012	5	0	0	0
2013	5	0	0	0

2. (Standard Research Target) Number of Patent Applications Submitted**Expected Patent Applications****2009 :0****2010 :0****2011 :0****2012 :0****2013 :0****3. Expected Peer Review Publications**

Year	Research Target	Extension Target	Total
2009	0	0	0
2010	0	0	0
2011	0	0	0
2012	0	0	0
2013	0	0	0

V(H). State Defined Outputs**1. Output Target**

- Scientific presentations and publications

2009 :1**2010 :1****2011 :1****2012 :1****2013 :1**

V(I). State Defined Outcome

O. No	Outcome Name
1	Increased awareness of soil remediation technology among stakeholders (%)
2	Development of a novel technique for soil remediation (% completion)
3	Increase restoration of reclaimed land and its use via this technique (%)

Outcome #1**1. Outcome Target**

Increased awareness of soil remediation technology among stakeholders (%)

2. Outcome Type : Change in Knowledge Outcome Measure**2009 :**0**2010 :** 0**2011 :** 0**2012 :**0**2013 :** 0**3. Associated Institute Type(s)**

•1890 Research

4. Associated Knowledge Area(s)

- 101 - Appraisal of Soil Resources
- 102 - Soil, Plant, Water, Nutrient Relationships
- 133 - Pollution Prevention and Mitigation
- 403 - Waste Disposal, Recycling, and Reuse

Outcome #2**1. Outcome Target**

Development of a novel technique for soil remediation (% completion)

2. Outcome Type : Change in Action Outcome Measure**2009 :**0**2010 :** 0**2011 :** 0**2012 :**0**2013 :** 0**3. Associated Institute Type(s)**

•1890 Research

4. Associated Knowledge Area(s)

- 101 - Appraisal of Soil Resources
- 102 - Soil, Plant, Water, Nutrient Relationships
- 133 - Pollution Prevention and Mitigation
- 403 - Waste Disposal, Recycling, and Reuse

Outcome #3**1. Outcome Target**

Increase restoration of reclaimed land and its use via this technique (%)

2. Outcome Type : Change in Condition Outcome Measure**2009 :**1**2010 :** 2**2011 :** 3**2012 :**4**2013 :** 5**3. Associated Institute Type(s)**

•1890 Research

4. Associated Knowledge Area(s)

- 101 - Appraisal of Soil Resources
- 102 - Soil, Plant, Water, Nutrient Relationships
- 133 - Pollution Prevention and Mitigation
- 403 - Waste Disposal, Recycling, and Reuse

V(J). Planned Program (External Factors)

1. External Factors which may affect Outcomes

- Competing Public priorities
- Public Policy changes
- Economy
- Government Regulations

Description

{NO DATA ENTERED}

V(K). Planned Program (Evaluation Studies and Data Collection)

1. Evaluation Studies Planned

- During (during program)
- Retrospective (post program)

Description

{NO DATA ENTERED}

2. Data Collection Methods

- Other (Site Experimentation)

Description

On site (reclaimed land at coal mines) experimentation is currently being designed. Data in relation to microbial and soil improvement (organic characteristics) will be collected.

V(A). Planned Program (Summary)**Program #2****1. Name of the Planned Program**

Aquaculture

2. Brief summary about Planned Program

This research program will focus on improving aquaculture production efficiency of cool water (rainbow trout) and warm water (channel catfish) fishes to be grown and marketed in West Virginia. Abundant supply of water from inactive deep coal mines in WV makes this state appropriate for the development of aquaculture. This program will evaluate the effects of different levels of recovered protein from thermophilic anaerobic digestion of poultry wastes on growth and body composition to determine the feasibility of using agricultural and municipal waste as a feed source to reduce protein costs in aquaculture diets. It will also determine the bioavailability of nutrients, especially nitrogen and phosphorus in feed formulated with the recovered protein. Another area of interest focuses on nutritional genomics (nutrigenomics), a study of the genome-wide influences of nutrition or dietary compounds on the transcriptome, proteome and metabolome of cells, tissues or organisms at a given time, with emphasis on aquaculture finfishes.

3. Program existence : Intermediate (One to five years)

4. Program duration : Long-Term (More than five years)

5. Expending formula funds or state-matching funds : Yes

6. Expending other than formula funds or state-matching funds : Yes

V(B). Program Knowledge Area(s)**1. Program Knowledge Areas and Percentage**

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
302	Nutrient Utilization in Animals				75%
307	Animal Management Systems				25%
	Total				100%

V(C). Planned Program (Situation and Scope)**1. Situation and priorities**

Today, aquaculture accounts for around 15% of total worldwide production of fish and seafood with 20 million tons of edible seafood coming from fish farmers. According to the World Aquaculture Association, aquaculture will have to play an increasingly important role in meeting the global demand for fisheries products as the world population continues to expand and fisheries stocks approach their biological limits. The availability of freshwater and the proximity to large population bases, along with the increased demand for fresh fish, make aquaculture a promising agriculture industry in West Virginia. While promising, aquaculture does face several economic, especially cost of production and environmental issues of water pollution. Improving production efficiency in aquaculture is a high priority area because one of the major costs in aquaculture is feed (30-50%), identifying and developing cheaper alternative protein sources and/or improving the efficiency of nutrient utilization is very important. Fish require high protein diets for optimal growth. Much of the protein is from animal sources and is expensive in comparison to other sources of protein. The cost of feed for aquaculture operations is the greatest operating expense. By replacing animal proteins with proteins from waste materials, the total cost of the feed can be reduced, resulting in higher profit margins for growers. Nitrogen and phosphorus discharge from aquaculture operations can impair nearby waterways, and result in discharge fees or fines for the operation. More effective feeding strategies and better formulated diets can help reduce the amount of nitrogen and phosphorus in

aquaculture discharge waters.

The efficient utilization of feed for growth and meat production is important for aquaculture. Feed efficiency (FE, weight gain to feed) or feed conversion ratio (FCR, feed to weight gain) is a composite measure that combine feed intake with growth rate to estimate effectiveness by which feed is converted into saleable meat product. Thus, FE or FCR is a major determinant of the production efficiency. Because mitochondrial function or biochemistry is reported to be associated with FE in other animals, understanding the biochemical and molecular mechanisms underpinning growth and the relationship between mitochondrial functions and feed efficiency in fishes is important. The central hypothesis is that growth efficiency depends on the metabolic efficiency of mitochondria and that there is a molecular/genomic/genetic basis for the relationship. Two feeding trials are currently underway to generate preliminary data on the relationship between mitochondrial function and feed efficiency in channel catfish.

2. Scope of the Program

- Multistate Research
- In-State Research

V(D). Planned Program (Assumptions and Goals)

1. Assumptions made for the Program

This program has been supported by CSREES and external grants. The scientist conducting research has experience with cool water and warm water species, such as trout, channel catfish, and ration formulation. WVSU has provided on campus laboratories and equipment for this program and collaborations have been established between the PD, other institutions (Mississippi State University), and scientists working at USDA-ARS institutions such as National Center for Cool and Cold Water Aquaculture and Catfish Genetic Research Unit. Currently the state of the aquaculture industry in West Virginia is still in development. This program will help address some of the issues preventing commercialization of aquaculture in southern West Virginia.

2. Ultimate goal(s) of this Program

- Ration formulation/bioavailability –reduce feed cost – reduce nutrient discharge into waterways.

- Protein replacement – reduce feed cost.

- Increased feed efficiency – reduce feed cost - reduce nutrient discharge into waterways, important criterion for selecting species for breeding.

V(E). Planned Program (Inputs)

1. Estimated Number of professional FTE/SYs to be budgeted for this Program

Year	Extension		Research	
	1862	1890	1862	1890
2009	0.0	0.0	0.0	1.0
2010	0.0	0.0	0.0	1.0
2011	0.0	0.0	0.0	1.0
2012	0.0	0.0	0.0	1.0
2013	0.0	0.0	0.0	1.0

V(F). Planned Program (Activity)

1. Activity for the Program

- Conduct research experiments - Present and/or publish research results

2. Type(s) of methods to be used to reach direct and indirect contacts

Extension	
Direct Methods	Indirect Methods
<ul style="list-style-type: none"> Other 1 (Scientific Conferences) 	<ul style="list-style-type: none"> Web sites

3. Description of targeted audience

- Aquaculture industry - Government regulatory agencies

V(G). Planned Program (Outputs)**1. Standard output measures**

Target for the number of persons(contacts) to be reached through direct and indirect contact methods

	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Year	Target	Target	Target	Target
2009	10	0	25	0
2010	10	0	25	0
2011	10	0	25	0
2012	10	0	25	0
2013	10	0	25	0

2. (Standard Research Target) Number of Patent Applications Submitted**Expected Patent Applications**

2009 :0

2010 :0

2011 :0

2012 :0

2013 :0

3. Expected Peer Review Publications

Year	Research Target	Extension Target	Total
2009	1	0	0
2010	1	0	0
2011	1	0	0
2012	1	0	0
2013	1	0	0

V(H). State Defined Outputs**1. Output Target**

- Presentations and/or publications

2009 :1

2010 :2

2011 :2

2012 :1

2013 :0

V(I). State Defined Outcome

O. No	Outcome Name
1	Lower feed costs (%)
2	Reduce nitrogen and phosphorus in discharged water (%)
3	Increased profitability of aquaculture operations (%)

Outcome #1**1. Outcome Target**

Lower feed costs (%)

2. Outcome Type : Change in Knowledge Outcome Measure**2009 :**0**2010 :** 0**2011 :** 0**2012 :**0**2013 :** 0**3. Associated Institute Type(s)**

•1890 Research

4. Associated Knowledge Area(s)

- 302 - Nutrient Utilization in Animals
- 307 - Animal Management Systems

Outcome #2**1. Outcome Target**

Reduce nitrogen and phosphorus in discharged water (%)

2. Outcome Type : Change in Action Outcome Measure**2009 :**20**2010 :** 0**2011 :** 0**2012 :**0**2013 :** 0**3. Associated Institute Type(s)**

•1890 Research

4. Associated Knowledge Area(s)

- 302 - Nutrient Utilization in Animals
- 307 - Animal Management Systems

Outcome #3**1. Outcome Target**

Increased profitability of aquaculture operations (%)

2. Outcome Type : Change in Condition Outcome Measure**2009 :**0**2010 :** 20**2011 :** 0**2012 :**0**2013 :** 0**3. Associated Institute Type(s)**

•1890 Research

4. Associated Knowledge Area(s)

- 302 - Nutrient Utilization in Animals
- 307 - Animal Management Systems

V(J). Planned Program (External Factors)**1. External Factors which may affect Outcomes**

- Economy
- Government Regulations

Description

{NO DATA ENTERED}

V(K). Planned Program (Evaluation Studies and Data Collection)

1. Evaluation Studies Planned

- During (during program)
- Retrospective (post program)

Description

{NO DATA ENTERED}

2. Data Collection Methods

- Other (Experimentation (Lab and Pilot))
- Sampling
- Observation

Description

Experiments to extract desired data will be conducted at WVSU's facilities as well as Mississippi State University, and The National Center for Cool and Cold Water Aquaculture.

V(A). Planned Program (Summary)**Program #3****1. Name of the Planned Program**

Environmental Microbiology

2. Brief summary about Planned Program

This research program consists of two related investigations that utilize molecular and genomics methods: 1. characterization of microbial community diversity in anaerobic digesters, and 2. linking microbial diversity to functionality and bioenergy conversions in digesters.

3. Program existence : Intermediate (One to five years)

4. Program duration : Long-Term (More than five years)

5. Expending formula funds or state-matching funds : Yes

6. Expending other than formula funds or state-matching funds : Yes

V(B). Program Knowledge Area(s)**1. Program Knowledge Areas and Percentage**

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
403	Waste Disposal, Recycling, and Reuse				100%
	Total				100%

V(C). Planned Program (Situation and Scope)**1. Situation and priorities**

Anaerobic digester technology for waste management is becoming a more attractive option for adding value to animal manure and improving nutrient management of associated nitrogen and phosphorus. WVSU has been operating a pilot plant digester for six years on campus. The function of digesters requires the metabolic cooperation of diverse communities of bacteria and archaea. In order to develop predictive models that link microbial diversity to digester performance, molecular methods are being used to characterize the microbial populations in the pilot plant digester and experimental laboratory-scale reactors that are operated under specific environmental conditions.

2. Scope of the Program

- Multistate Research
- In-State Research

V(D). Planned Program (Assumptions and Goals)**1. Assumptions made for the Program**

The program is using facilities and equipment on the campus of WVSU, including a 40 cubic meter anaerobic digester pilot plant, a 30 liter lab scale digester, and two laboratories. One research scientist, a PhD candidate and several undergraduate and graduate students are currently working on projects within this program. The program receives partial funding from CSREES formula funds, with most of the funding from external grants. The scientist and students have extensive knowledge of molecular DNA techniques and the characterization of anaerobic bacteria.

2. Ultimate goal(s) of this Program

1. Anaerobic digester microbial community characterization: develop an understanding of microbial community processes that enable biomass-to-bioenergy conversions. 2. Develop predictive profiles of microbial diversity that can be used as a monitoring

tool for anaerobic digester operators and engineers.

V(E). Planned Program (Inputs)

1. Estimated Number of professional FTE/SYs to be budgeted for this Program

Year	Extension		Research	
	1862	1890	1862	1890
2009	0.0	0.0	0.0	2.6
2010	0.0	0.0	0.0	2.6
2011	0.0	0.0	0.0	2.6
2012	0.0	0.0	0.0	2.6
2013	0.0	0.0	0.0	2.6

V(F). Planned Program (Activity)

1. Activity for the Program

- Conduct research experiments - Present and/or publish findings

2. Type(s) of methods to be used to reach direct and indirect contacts

Extension	
Direct Methods	Indirect Methods
<ul style="list-style-type: none"> ● Education Class ● Other 1 (Scientific Conferences) 	<ul style="list-style-type: none"> ● Newsletters ● Web sites

3. Description of targeted audience

- Anaerobic digester engineers and operators - Poultry industry - Livestock producers - Microbiology researchers

The target audience of this research is microbiologists and engineers who work on anaerobic digestion as well as other environmental biotechnologists interested in biomass-to-bioenergy production. In addition, anaerobic digester operators and livestock and poultry farmers will benefit.

V(G). Planned Program (Outputs)

1. Standard output measures

Target for the number of persons(contacts) to be reached through direct and indirect contact methods

	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Year	Target	Target	Target	Target
2009	10	0	0	0
2010	10	0	0	0
2011	10	0	0	0
2012	10	0	0	0
2013	10	0	0	0

2. (Standard Research Target) Number of Patent Applications Submitted

Expected Patent Applications

2009 :0 2010 :0 2011 :0 2012 :0 2013 :0

3. Expected Peer Review Publications

Year	Research Target	Extension Target	Total
2009	0	0	0
2010	0	0	0
2011	0	0	0
2012	0	0	0
2013	0	0	0

V(H). State Defined Outputs

1. Output Target

- Scientific publications and/or presentations

2009 :2 2010 :2 2011 :2 2012 :2 2013 :2

V(I). State Defined Outcome

O. No	Outcome Name
1	Increase knowledge of anaerobic bacteria (%)
2	Increase digester efficiency (%)
3	Increase knowledge of microbial biomass-to-bioenergy conversion process (%)

Outcome #1**1. Outcome Target**

Increase knowledge of anaerobic bacteria (%)

2. Outcome Type : Change in Knowledge Outcome Measure**2009 :**0**2010 :** 0**2011 :** 0**2012 :**0**2013 :** 0**3. Associated Institute Type(s)**

•1890 Research

4. Associated Knowledge Area(s)

- 403 - Waste Disposal, Recycling, and Reuse

Outcome #2**1. Outcome Target**

Increase digester efficiency (%)

2. Outcome Type : Change in Condition Outcome Measure**2009 :**10**2010 :** 0**2011 :** 0**2012 :**0**2013 :** 0**3. Associated Institute Type(s)**

•1890 Research

4. Associated Knowledge Area(s)

- 403 - Waste Disposal, Recycling, and Reuse

Outcome #3**1. Outcome Target**

Increase knowledge of microbial biomass-to-bioenergy conversion process (%)

2. Outcome Type : Change in Knowledge Outcome Measure**2009 :**5**2010 :** 7**2011 :** 9**2012 :**11**2013 :** 13**3. Associated Institute Type(s)**

•1890 Research

4. Associated Knowledge Area(s)

- 403 - Waste Disposal, Recycling, and Reuse

V(J). Planned Program (External Factors)**1. External Factors which may affect Outcomes**

- Government Regulations
- Economy

Description

{NO DATA ENTERED}

V(K). Planned Program (Evaluation Studies and Data Collection)**1. Evaluation Studies Planned**

- Before-After (before and after program)
- Retrospective (post program)

Description

{NO DATA ENTERED}

2. Data Collection Methods

- Other (Experimentation (Lab and Pilot))
- Tests

Description

Microbial community diversity in anaerobic digesters will be sampled using several molecular methods that access DNA sequence variability found in phylogenetically and functionally informative genes. The diversity of both bacteria and archaea will be studied. Methods include cloning, sequencing, T-RFLP and microarrays. The experimental system consists of a pilot plant thermophilic anaerobic digester located at West Virginia State University. In addition, laboratory scale digesters will be used for manipulating environmental variables and conducting isotope labeling experiments. Different digesters from world-wide sites will be sampled for a comparative analysis of microbial diversity and functionality.

V(A). Planned Program (Summary)**Program #4****1. Name of the Planned Program**

Plant Genomics

2. Brief summary about Planned Program

This research program consists of two projects already in progress. A hydroponic tomato breeding project and a pepper, sweet potato, and watermelon gene mapping project will be continued. Each project involves investigation of genetic markers for insect and disease resistance, superior yield, and superior quality of harvested product. The greenhouse hydroponic research focuses on developing new lines of tomatoes especially for North American production systems. The pepper and watermelon research focuses on mapping specific traits using DNA marker technology. Related research at West Virginia University will focus on determining the function of ubiquitin and other polypeptide tags, to understand mechanisms of flower senescence.

3. Program existence : Intermediate (One to five years)

4. Program duration : Long-Term (More than five years)

5. Expending formula funds or state-matching funds : Yes

6. Expending other than formula funds or state-matching funds : Yes

V(B). Program Knowledge Area(s)**1. Program Knowledge Areas and Percentage**

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
201	Plant Genome, Genetics, and Genetic Mechanisms				50%
202	Plant Genetic Resources				35%
204	Plant Product Quality and Utility (Preharvest)				15%
	Total				100%

V(C). Planned Program (Situation and Scope)**1. Situation and priorities**

The application of DNA marker technology for genetic improvement of pepper and watermelon is essential for genetic mapping and for gene manipulation. A gene mapping project focuses on building extensive genomic resources for these crops and identifying germplasm with disease and pest resistant genes. Currently, most of the varieties used in greenhouse hydroponic tomato production are bred for northern European conditions and palate. Even though these plants are grown in North American greenhouses, the European environment selects for plants with a lower light requirement in the winter and a more moderate temperature year round than is found in North America. Thus, while these varieties can produce a crop under our conditions, they are not selected for the North American greenhouse environment or our consumer needs. This research will develop lines suitable for North American production systems.

2. Scope of the Program

- In-State Research
- Multistate Research

V(D). Planned Program (Assumptions and Goals)**1. Assumptions made for the Program**

Three research scientist will conduct this research with support from CSREES and external grant funding. These scientists will be assisted by graduate students, technicians, and post doctorate researchers, all with specific knowledge regarding molecular genetics techniques and equipment. Several laboratories, two greenhouses, and an on campus field station have been wholly or partially committed to this program.

2. Ultimate goal(s) of this Program

- Develop a greenhouse beefsteak tomato variety for southern greenhouse tomato producers - Build extensive genomic resources for these crops and identify diverse germplasm with pest/disease resistant and nutraceutical genes.

V(E). Planned Program (Inputs)**1. Estimated Number of professional FTE/SYs to be budgeted for this Program**

Year	Extension		Research	
	1862	1890	1862	1890
2009	0.0	0.0	0.0	5.2
2010	0.0	0.0	0.0	5.2
2011	0.0	0.0	0.0	5.2
2012	0.0	0.0	0.0	5.2
2013	0.0	0.0	0.0	5.2

V(F). Planned Program (Activity)**1. Activity for the Program**

- Conduct research experiments - Present and/or publish research findings

2. Type(s) of methods to be used to reach direct and indirect contacts

Extension	
Direct Methods	Indirect Methods
<ul style="list-style-type: none"> Other 1 (Scientific Conferences) 	<ul style="list-style-type: none"> Web sites

3. Description of targeted audience

- Greenhouse industry - Horticulturists - Plant genetics researchers

V(G). Planned Program (Outputs)**1. Standard output measures**

Target for the number of persons(contacts) to be reached through direct and indirect contact methods

	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Year	Target	Target	Target	Target
2009	0	0	0	0
2010	0	0	0	0
2011	0	0	0	0
2012	0	0	0	0
2013	0	0	0	0

2. (Standard Research Target) Number of Patent Applications Submitted

Expected Patent Applications

2009 :2 2010 :2 2011 :2 2012 :2 2013 :2

3. Expected Peer Review Publications

Year	Research Target	Extension Target	Total
2009	0	0	0
2010	0	0	0
2011	0	0	0
2012	0	0	0
2013	0	0	0

V(H). State Defined Outputs

1. Output Target

- Scientific publications and/or presentations

2009 :2 2010 :2 2011 :2 2012 :2 2013 :0

V(I). State Defined Outcome

O. No	Outcome Name
1	Increase profitability of hydroponic tomatoes (%)
2	Gene map for vegetable crops (#)

Outcome #1**1. Outcome Target**

Increase profitability of hydroponic tomatoes (%)

2. Outcome Type : Change in Condition Outcome Measure**2009 :**0**2010 :** 20**2011 :** 0**2012 :**0**2013 :** 0**3. Associated Institute Type(s)**

•1890 Research

4. Associated Knowledge Area(s)

- 201 - Plant Genome, Genetics, and Genetic Mechanisms
- 202 - Plant Genetic Resources
- 204 - Plant Product Quality and Utility (Preharvest)

Outcome #2**1. Outcome Target**

Gene map for vegetable crops (#)

2. Outcome Type : Change in Action Outcome Measure**2009 :**2**2010 :** 2**2011 :** 2**2012 :**2**2013 :** 0**3. Associated Institute Type(s)**

•1890 Research

4. Associated Knowledge Area(s)

- 201 - Plant Genome, Genetics, and Genetic Mechanisms
- 202 - Plant Genetic Resources
- 204 - Plant Product Quality and Utility (Preharvest)

V(J). Planned Program (External Factors)**1. External Factors which may affect Outcomes**

- Natural Disasters (drought,weather extremes,etc.)
- Economy

Description

{NO DATA ENTERED}

V(K). Planned Program (Evaluation Studies and Data Collection)**1. Evaluation Studies Planned**

- Retrospective (post program)
- During (during program)

Description

{NO DATA ENTERED}

2. Data Collection Methods

- Other (Greenhouse & Lab Experiments)

Description

Genetic testing is conducted in school and commercial laboratories. Crop production data is collected in greenhouses and field trials.

V(A). Planned Program (Summary)**Program #5****1. Name of the Planned Program**

Agricultural Biotechnology

2. Brief summary about Planned Program

This program involves fundamental research in biochemistry of proteins of agronomic importance. The initial studies proposed the investigation of Rubisco (the carbon dioxide fixing enzyme in photosynthesis). However, the actual studies were refocused on determining the mechanism of action of tryptophan monooxygenase (TMO) from *Agrobacterium tumefaciens*. Tryptophan monooxygenase (TMO) from *Agrobacterium tumefaciens* is responsible for crown gall disease in plants. Novel information on structure function relationships of TMO could be used to increase the yield of numerous crops. The initial project includes cloning, expressing, isolating and characterizing TMO, understanding the kinetics of enzyme on substrate specificity and catalysis, identifying the critical protein sequence on activity, and designing novel inhibitors.

3. Program existence : Intermediate (One to five years)

4. Program duration : Medium Term (One to five years)

5. Expending formula funds or state-matching funds : Yes

6. Expending other than formula funds or state-matching funds : Yes

V(B). Program Knowledge Area(s)**1. Program Knowledge Areas and Percentage**

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
206	Basic Plant Biology				100%
	Total				100%

V(C). Planned Program (Situation and Scope)**1. Situation and priorities**

Tryptophan monooxygenase is a flavoenzyme, catalyzes the oxidative decarboxylation of α -amino acids, catalyzes the tryptophan to indoleacetamide and carbon dioxide and water. This is the first step in the synthesis of plant growth hormone by pathogenic bacteria. Upon infection of plants by *Agrobacterium tumefaciens*, organism produces enzymes required to form Indoleacetic acid at the site of infection. The resulting high levels of IAA at the site of infection results in localized growths, known as galls. Because of the localized growth, health of the plant is compromised. None of the basic enzyme parameters like substrate affinity constants or reactions rates for the TMO of *A. tumefaciens* have so far been established. And also no structural information of any TMO is yet available. Because of its role in the tumorigenesis, the regulation of IAA synthesis is of interest. Studies on the structure and catalytic mechanisms of TMO will help in developing inhibitors. Such inhibitors will prevent the formation of galls on the infected plants and there by block the deleterious effects of the infection and increase the agricultural yield.

2. Scope of the Program

- In-State Research
- Multistate Research

V(D). Planned Program (Assumptions and Goals)**1. Assumptions made for the Program**

The research scientist will conduct this research with support from CSREES and external grant funds. Scientist will be assisted by graduate students, technicians, and post doctorate researchers, if and when available, all with special knowledge regarding biochemical and proteomic techniques and equipment.

2. Ultimate goal(s) of this Program

To increase plant/crop yield and productivity.

V(E). Planned Program (Inputs)**1. Estimated Number of professional FTE/SYs to be budgeted for this Program**

Year	Extension		Research	
	1862	1890	1862	1890
2009	0.0	0.0	0.0	1.8
2010	0.0	0.0	0.0	1.8
2011	0.0	0.0	0.0	1.8
2012	0.0	0.0	0.0	1.8
2013	0.0	0.0	0.0	1.8

V(F). Planned Program (Activity)**1. Activity for the Program**

- Expression, purification, and characterization studies of TMO which will assist in developing crop pathogenic inhibitors.
- Scientific publications and/or presentations

2. Type(s) of methods to be used to reach direct and indirect contacts

Extension	
Direct Methods	Indirect Methods
<ul style="list-style-type: none"> • Other 1 (Scientific Experimentation) • Other 2 (DNA/Protein Methodologies) 	<ul style="list-style-type: none"> • Web sites

3. Description of targeted audience

- Plant physiology researchers
- Biochemists
- Agriculture biotechnology companies
- Agricultural Crop Producers/Growers

V(G). Planned Program (Outputs)**1. Standard output measures**

Target for the number of persons(contacts) to be reached through direct and indirect contact methods

	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Year	Target	Target	Target	Target
2009	5	0	0	0
2010	5	0	0	0
2011	5	0	0	0
2012	5	0	0	0
2013	5	0	0	0

2. (Standard Research Target) Number of Patent Applications Submitted

Expected Patent Applications

2009 :0 2010 :0 2011 :0 2012 :0 2013 :0

3. Expected Peer Review Publications

Year	Research Target	Extension Target	Total
2009	1	0	1
2010	1	0	1
2011	1	0	1
2012	1	0	1
2013	1	0	1

V(H). State Defined Outputs

1. Output Target

- Scientific presentations/publications

2009 :1 2010 :2 2011 :2 2012 :2 2013 :0

V(I). State Defined Outcome

O. No	Outcome Name
1	Improve plant/crop yield/productivity (%)

Outcome #1

1. Outcome Target

Improve plant/crop yield/productivity (%)

2. Outcome Type : Change in Condition Outcome Measure

2009 :5

2010 : 5

2011 : 5

2012 :5

2013 : 5

3. Associated Institute Type(s)

- 1890 Research

4. Associated Knowledge Area(s)

- 206 - Basic Plant Biology

V(J). Planned Program (External Factors)

1. External Factors which may affect Outcomes

- Other (Other research findings)

Description

Since this is a fundamental research program, findings by other researchers may modify the techniques and procedures used to improve the experiments.

V(K). Planned Program (Evaluation Studies and Data Collection)

1. Evaluation Studies Planned

- Retrospective (post program)
- Other (Program Annual Evaluation)
- During (during program)

Description

Programs and personnel undergo an annual review and evaluation based on performance measures.

2. Data Collection Methods

- Other (Laboratory Experimentation)
- Tests

Description

Protein/DNA methodologies will be used to obtain data through experimentation.

V(A). Planned Program (Summary)**Program #6****1. Name of the Planned Program**

Alternative Agriculture

2. Brief summary about Planned Program

This research program consists of one project already in progress. This work will have three production foci: hydroponic, organic/sustainable and ornamental. Each of these foci may involve varietal selection; germplasm characterization and evaluation; nutrient and pest management; soil/media quality and plant performance; production practices and postharvest quality; and production practices to improve plant systems. The overall objective of this project is to develop and demonstrate hydroponic, sustainable/organic and ornamental technology and/or production systems suitable for use by small producers.

3. Program existence : Intermediate (One to five years)

4. Program duration : Medium Term (One to five years)

5. Expending formula funds or state-matching funds : Yes

6. Expending other than formula funds or state-matching funds : Yes

V(B). Program Knowledge Area(s)**1. Program Knowledge Areas and Percentage**

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
201	Plant Genome, Genetics, and Genetic Mechanisms				25%
205	Plant Management Systems				75%
	Total				100%

V(C). Planned Program (Situation and Scope)**1. Situation and priorities**

Alternative agriculture products and practices such as organic farming and hydroponic systems are becoming an important component in North American agriculture. Alternative approaches to growing traditional crops, and the production of new or exotic species not currently grown on a large-scale commercial basis in the USA, can provide a greater return on small farm investment compared to traditional products and practices. In areas such as southern West Virginia, with economic instability due to the transition from an industrial and forestry based economy to a service and technology based economy, income from small farms could provide an important source of income for landowners in these regions. Other potential areas of alternative production include organic farming, ornamental and herb production, and hydroponic plant production.

2. Scope of the Program

- Multistate Research
- In-State Research

V(D). Planned Program (Assumptions and Goals)**1. Assumptions made for the Program**

One research scientist will conduct this research with support from CSREES and external grant funding. This scientist will be assisted by undergraduate students, graduate students, and technicians, all with specific knowledge regarding horticultural

production and management. Research projects will be conducted in laboratories, greenhouse facilities, and an on campus field station.

2. Ultimate goal(s) of this Program

Develop and demonstrate hydroponic, sustainable/organic and ornamental technology and/or production systems suitable for use by small producers.

V(E). Planned Program (Inputs)

1. Estimated Number of professional FTE/SYs to be budgeted for this Program

Year	Extension		Research	
	1862	1890	1862	1890
2009	0.0	0.0	0.0	1.0
2010	0.0	0.0	0.0	1.0
2011	0.0	0.0	0.0	1.0
2012	0.0	0.0	0.0	1.0
2013	0.0	0.0	0.0	1.0

V(F). Planned Program (Activity)

1. Activity for the Program

- Conduct research experiments
- Publications and Presentations

2. Type(s) of methods to be used to reach direct and indirect contacts

Extension	
Direct Methods	Indirect Methods
<ul style="list-style-type: none"> Other 1 (Presentations) 	<ul style="list-style-type: none"> Web sites

3. Description of targeted audience

- Farmers/growers
- Organic farmers/growers
- Hydroponic growers
- Greenhouse growers
- Horticulturists

V(G). Planned Program (Outputs)

1. Standard output measures

Target for the number of persons(contacts) to be reached through direct and indirect contact methods

	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Year	Target	Target	Target	Target
2009	20	0	0	0
2010	30	0	0	0
2011	40	0	0	0
2012	50	0	0	0
2013	50	0	0	0

2. (Standard Research Target) Number of Patent Applications Submitted

Expected Patent Applications

2009 :0 2010 :0 2011 :0 2012 :0 2013 :0

3. Expected Peer Review Publications

Year	Research Target	Extension Target	Total
2009	1	0	0
2010	1	0	0
2011	1	0	0
2012	1	0	0
2013	1	0	0

V(H). State Defined Outputs

1. Output Target

- Scientific presentations/publications

2009 :2 2010 :2 2011 :3 2012 :3 2013 :0

V(I). State Defined Outcome

O. No	Outcome Name
1	Increase small farm profitability %

Outcome #1

1. Outcome Target

Increase small farm profitability %

2. Outcome Type : Change in Action Outcome Measure

2009 :2 2010 : 2 2011 : 3 2012 :3 2013 : 0

3. Associated Institute Type(s)

•1890 Research

4. Associated Knowledge Area(s)

- 201 - Plant Genome, Genetics, and Genetic Mechanisms
- 205 - Plant Management Systems

V(J). Planned Program (External Factors)

1. External Factors which may affect Outcomes

- Economy
- Natural Disasters (drought,weather extremes,etc.)

Description

{NO DATA ENTERED}

V(K). Planned Program (Evaluation Studies and Data Collection)

1. Evaluation Studies Planned

- Retrospective (post program)
- During (during program)

Description

{NO DATA ENTERED}

2. Data Collection Methods

- Tests
- Other (Experimentation)

Description

Data are collected at the campus or farmers' field trials.